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means, objects, and advantages set forth hereinbefore. It is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications, and variations as fall within the spirit and broad scope of the appended claims.

What is claimed is:

1. A method for forming a molded article comprising the steps of:

forming a molded article within a mold;

removing said molded article from said mold while said article retains an amount of heat; and

directing a flow of cooling fluid toward an interior region of said molded article where crystallization occurs so as to substantially prevent said crystallization in said region and thereby form a molded article which is substantially free of any crystallized portion.

2. The method of claim 1, wherein said directing step comprises creating an annular flow of said cooling fluid within said interior region of said molded article so as to substantially prevent said crystallization.

3. The method according to claim 1, wherein said directing step comprises directing said cooling fluid toward a dome

portion of said molded article and contacting said dome portion with said cooling fluid.

4. The method according to claim 1, wherein said directing step comprises directing said cooling fluid toward a sprue gate portion of said molded article and contacting said sprue gate portion with said cooling fluid.

5. The method according to claim 1, wherein said directing step comprises:

inserting a pin having at least one internal passageway and an outlet nozzle into the interior of said molded article;

spacing said outlet nozzle a distance d from an interior wall surface sufficient to create an annular flow of said cooling fluid; and

blowing said cooling fluid onto said interior region via said pin.

6. The method according to claim 5 further comprising aligning a central axis of said cooling pin with a central axis of the molded article.

7. The method according to claim 6 wherein said cooling pin has an upper portion and an exterior surface of said upper portion is spaced from an interior surface of said molded article by a distance D and said step of spacing said outlet nozzle comprises spacing said outlet nozzle so that the ratio of d:D is in the range of about 1:1 to about 10:1.

8. The method according to claim 5, further comprising:

connecting said at least one internal passageway to a source of cooled, pressurized air; and

said blowing step comprising blowing said air onto said interior region.

9. The method according to claim 5, further comprising:

said inserting step further comprising forming an annular space between interior surfaces of said molded article and said pin; and

allowing said cooling fluid to flow through said annular space and escape into the ambient environment.

10. The method according to claim 1, further comprising cooling exterior portions of said molded article after said molded article has been removed from said mold.

11. The method according to claim 10, wherein said exterior portion cooling step is performed simultaneously with said directing step.

12. The method according to claim 10, wherein said exterior portion cooling step is performed at least partially simultaneously with said directing step.

13. The method according to claim 10, wherein said exterior portion cooling step is performed sequentially with said directing step.

14. The method according to claim 10, wherein said exterior portion cooling step comprises cooling said exterior portions by heat conduction.

15. The method according to claim 10, wherein said exterior portion cooling step comprises placing said exterior portions of said molded article in direct contact with a chilled surface.

16. The method according to claim 10, wherein said exterior portion cooling step comprises cooling said exterior surfaces by convective heat transfer.

17. The method according to claim 16, further comprising:

providing a take-off plate having a holder for said molded article, said holder having a plurality of openings for exposing outer surfaces of said molded article to a flow of cooling fluid;

said removing step comprising loading said molded article into said holder in said take-off plate; and

said exterior cooling step comprising providing a cooling platform with a plurality of nozzles and blowing a cooling fluid through said nozzles and through said openings in said holder onto said outer surfaces of said molded article.

18. The method according to claim 1, further comprising:

said forming step comprising forming a plurality of molded articles in said mold; and

said removing step comprises providing a carrier having receptacles for said molded articles and transferring said molded articles to said receptacles.

19. The method according to claim 18 further comprising cooling exterior portions of said molded articles while said molded articles are in said receptacles and being transported by said carrier to a position outboard of said mold.

20. The method according to claim 18, further comprising:

providing a frame having pin means for directing said cooling fluid; and

moving said frame relative to said carrier so as to insert said pin means deeply into the interiors of said molded articles while said molded articles are in said receptacles.

21. The method according to claim 20, wherein said directing step comprises blowing cooling fluid through said pin means onto said interior regions of said molded articles while said molded articles are in said receptacles.

22. The method according to claim 21, wherein said blowing step comprises blowing a cooling gas onto said interior regions where crystallinity occurs.

23. The method according to claim 18, further comprising:

said molded article forming step comprising forming a plurality of preforms; and

blowing each of said preforms into final decrystallized articles.

24. The method according to claim 1, further comprising:

said forming step comprising forming a first set of molded articles in a mold formed by two mold halves; and

said removing step comprises providing a carrier having a plurality of receptacles for receiving said molded articles, moving said carrier to a first position between said two mold halves, transferring said molded articles to said receptacles while said carrier is in said first position, and moving said carrier with said molded articles in said receptacles to a second position outside of said mold.

25. The method according to claim 24, further comprising cooling exterior portions of said molded articles while said molded articles are in said receptacles and said carrier is being moved to said second position.

26. The method according to claim 24, further comprising said directing step comprising directing a flow of cooling fluid into the interior of each of said molded articles of said first set so as to substantially prevent crystallization in said interior region of each said molded article.

27. The method according to claim 26, wherein said directing step commences when said carrier reaches said second position.

28. The method according to claim 24, further comprising:

providing a frame having a plurality of cooling pins;

moving said frame relative to said carrier so as to insert said cooling pins into the interior of said molded articles forming said first set; and

said directing step comprising directing a flow of cooling fluid into the interior of each of said molded articles of said first set via said cooling pins so as to substantially prevent crystallization in said interior region of each said molded articles.

29. The method according to claim 28, further comprising:

sensing the temperature of each of said molded articles; and

adjusting the flow of cooling fluid into the interior of said molded articles in response to said sensed temperatures.

30. The method according to claim 29, wherein said adjusting step comprises adjusting valve means associated with said cooling pins so as to adjust the flow of cooling fluid through individual ones of said cooling pins.

31. The method according to claim 28, further comprising directing said cooling fluid into the interiors of said molded articles at a first rate of flow during a first portion of a cooling cycle and at a second, lower rate of flow during a second portion of said cooling cycle.

32. The method according to claim 28, further comprising:

withdrawing said cooling pins from the interior of said molded articles;

moving said carrier back to said first position;

transferring a second set of molded articles into said receptacles within said carrier while said first

set of molded articles is still within said receptacles in said carrier; and

returning said carrier with said first and second sets of molded articles to said second position.

33. The method according to claim 32, further comprising:

inserting said cooling pins into the interiors of said molded articles in said first and second sets; and

simultaneously effecting cooling of the interiors of said molded articles.

34. The method according to claim 33, further comprising cooling exterior surfaces of said molded articles.

35. The method according to claim 33, wherein said simultaneous cooling step includes the step of directing a flow of cooling fluid into the interior of each of said molded articles of said first and second sets via said cooling pins so as to substantially prevent crystallization in said interior region of each molded article.

36. The method of according to claim 34, further comprising

withdrawing said cooling pins from the interior of said molded articles;

moving said carrier back to said first position;

transferring a third set of molded articles into said receptacles within said carrier while said first and second sets of molded articles are still within said receptacles in said carrier; and

returning said carrier with said first, second and third sets of molded articles to said second position.

37. The method according to claim 36, further comprising:

providing said frame with a plurality of apertures;

inserting said cooling pins into the interiors of said molded articles in said second and third molded sets; and

ejecting said molded articles of said first set through said apertures onto a transfer device.

38. The method according to claim 28, further comprising:

providing a cooling station having a plurality of nozzles connected to a source of cooling fluid;

positioning said cooling station adjacent said carrier; and

directing cooling fluid onto exterior surfaces of said molded articles by blowing cooling fluid through openings in said receptacles onto said exterior surfaces.

39. The method according to claim 38, further comprising applying a vacuum to each of said molded articles to hold said articles in said receptacles during said exterior cooling step.

40. An apparatus for forming a molded article which comprises:

mold means for forming a molded article;

means for removing said molded article from said mold means while said molded article retains an amount of heat; and

means for directing cooling fluid onto an interior region of said molded article where crystallinity occurs after said molded article has been removed from said mold means so as to form a molded article substantially free of any crystallized portion.

41. The apparatus according to claim 40, wherein said directing means comprises means for creating an annular flow of cooling fluid within said interior region of said molded article so as to substantially prevent crystallization in said molded article.

42. The apparatus according to claim 40, wherein said directing means comprises means for directing a cooling fluid onto a dome portion of the molded article.

43. The apparatus according to claim 40, wherein said directing means comprises means for directing a cooling fluid onto a sprue gate portion of the molded article.

44. The apparatus according to claim 40, wherein said directing means comprises means for blowing a cooling gas onto said interior region.

45. The apparatus according to claim 44, wherein said blowing means comprises means for blowing cooled, pressurized air onto said interior region.

46. The apparatus according to claim 44, wherein said blowing means comprises a cooling pin inserted within the interior of said molded article, and wherein said cooling pin has at least one passageway communicating with a source of cooling gas.

47. The apparatus according to claim 44, wherein said cooling pin has a central axis aligned with a central axis of said molded article and is spaced from interior surfaces of said molded article by a distance D so as to form an annular space between said interior surfaces and said cooling pin.

48. The apparatus according to claim 47, wherein said cooling pin has an outlet nozzle and said outlet nozzle is spaced from the interior surface of said dome portion by a distance d and wherein the ratio of d:D is in the range of

from about 1:1 to about 10:1 so as to create an annular flow of said cooling fluid.

49. The apparatus according to claim 48, wherein said outlet nozzle is formed by a divergent nozzle structure.

50. The apparatus according to claim 47, wherein said cooling gas circulates through said annular space and escapes into the ambient atmosphere.

51. The apparatus according to claim 40, further comprising said removing means comprising a carrier having a receptacle for receiving said molded article.

52. The apparatus according to claim 51, wherein said carrier has means for cooling exterior surfaces of said molded article by conduction while said molded article is within said receptacle so that the shape of said article is maintained without any deformation.

53. The apparatus according to claim 51, wherein said receptacle comprises a water-cooled tube within said carrier.

54. The apparatus according to claim 51, wherein:

said mold means comprises a mold formed by two mold halves; and

said carrier may be indexed between a first position intermediate said mold halves and a second position outboard of said mold halves.

55. The apparatus according to claim 54, wherein said mold has means for cooling said molded article to a temperature substantially close to the crystal-glass transition temperature so that the molded article may be handled outside the mold without suffering any geometrical deformation.

56. The apparatus according to claim 54, further comprising said directing means comprising a cooling pin to be inserted into interior portions of said molded article while said molded article is within said receptacle.

57. The apparatus according to claim 56, wherein said cooling pin is mounted on a frame which moves relative to and independently of said carrier.

58. The apparatus according to claim 56, wherein said carrier includes a plurality of receptacles for holding a plurality of molded articles and said directing means comprises a plurality of cooling pins mounted to a frame, which frame is movable relative to the carrier.

59. The apparatus according to claim 58, wherein said cooling pins are equal in number to said receptacles.

60. The apparatus according to claim 58, wherein said cooling pins are less in number than said receptacles.

61. The apparatus according to claim 58, wherein said frame includes a plurality of apertures for allowing cooled ones of said molded articles to be ejected from said carrier while said cooling pins are engaged with certain ones of said molded articles which have not completed a cooling cycle.

62. The apparatus according to claim 58, further comprising:

said frame having a passageway connected to a source of said cooling fluid; and

said pins each communicating with said passageway.

63. The apparatus according to claim 62, further comprising valve means for supplying regulated amounts of said cooling fluid to each said cooling pin.

64. The apparatus according to claim 63, wherein the amount of cooling fluid supplied to each individual cooling pin is regulated by said valve means in accordance with a particular stage of a cooling cycle.

65. The apparatus according to claim 62, further comprises means for sensing the temperature of each molded article and means for controlling the amount of fluid supplied to each said pin in response to the sensed temperatures of said molded articles.

66. The apparatus according to claim 58, wherein each said cooling pin includes means for removing a respective one of said molded articles from its receptacle.

67. The apparatus according to claim 66, further comprising means for moving said frame between a first position and a second position where said molded articles are ejected from

said cooling pins by ceasing operation of said removing means.

68. The apparatus according to claim 67, wherein said frame moving means comprises cam means for converting translation of said frame into rotation of said frame.

69. The apparatus according to claim 58, wherein said carrier includes means for holding said molded articles within said receptacles and means for ejecting the molded articles from said receptacles after cooling has been completed.

70. The apparatus according to claim 58, wherein each of said cooling pins has a first portion with a first diameter and a second portion with a second diameter, which second diameter is different from said first diameter.

71. The apparatus according to claim 58, wherein each of said cooling pins has lateral outlets for discharging said cooling fluid onto sidewalls of the molded articles where crystallinity occurs.

72. The apparatus according to claim 58, wherein each of said cooling pins means has helical grooves in its exterior surface.

73. The apparatus according to claim 58, wherein each of said cooling pins has a plurality of ribs spaced about its periphery.

74. The apparatus according to claim 58, wherein each of said cooling pins has a plurality of contact elements spaced around its periphery.

75. The apparatus according to claim 58, wherein each of said cooling pins concentrates maximum cooling at a dome portion of the respective molded article in which it is positioned.

76. The apparatus according to claim 58, wherein each said cooling pin includes means for removing cooling fluid from the interior of said molded article.

77. The apparatus according to claim 58, wherein each said cooling pin has an approximate U-shape and is movable between a first position where one arm of said U-shaped cooling pin is positioned within said molded article and a

second position where said one arm is withdrawn from said molded article.

78. The apparatus according to claim 77, further comprising means for axially moving each said U-shaped pin between said first and second positions.

79. The apparatus according to claim 78, further comprising means for rotating each said U-shaped cooling pin to a third position where said one arm of each said U-shaped cooling pin does not interfere with removal of said molded articles from said carrier.

80. The apparatus according to claim 58, wherein each of said cooling pins is formed from a porous material so that cooling fluid can be applied in a substantially uniform manner to multiple portions of said molded article.

81. The apparatus according to claim 58, wherein each of said cooling pins has a plurality of radial conduits for applying coolant to multiple portions of said molded article.

82. The apparatus according to claim 56, further comprising means for cooling exterior surfaces of said molded article by heat convection transfer.

83. The apparatus according to claim 82, wherein said exterior surfaces cooling means comprises means external to said carrier for blowing a cooling fluid onto said exterior surfaces of said molded article.

84. The apparatus according to claim 83, wherein said carrier has a receptacle for holding said molded article and said receptacle has openings in its side and bottom walls and wherein said external blowing means blows cooling fluid through said openings onto said exterior surfaces.

85. The apparatus according to claim 58, further comprising means for cooling exterior surfaces of said molded articles by heat convection transfer.

86. The apparatus according to claim 85, wherein said external surface cooling means comprises means external to said carrier for directing cooling fluid against said exterior surfaces of said molded articles.

87. The apparatus according to claim 86, wherein each of said receptacles has openings in its side and bottom walls and wherein said external cooling fluid directing means blows cooling fluid through said openings onto said exterior surfaces.

88. The apparatus according to claim 87, further comprising vacuum means for holding each of said molded articles in a respective one of said receptacles.

89. A method for forming a molded article comprising the steps of:

forming a molded article within a mold;

removing said molded article from said mold while said article retains sufficient heat to cause crystallinity in said molded article;

inserting a cooling pin in said molded article; and

creating an annular flow of cooling fluid within a dome portion of said molded article so as to prevent crystallization at least within said dome portion.

90. The method according to claim 89, further comprising aligning a central axis of said cooling pin with a central axis of the molded article so that an exterior surface of said cooling pin is a distance D from an interior surface of said molded article.

91. The method according to claim 90, further comprising:

spacing an outlet nozzle of said cooling pin a distance d from an interior surface of said dome portion; and

said annular flow creating step comprising positioning said cooling pin so that the ratio of d:D is in the range of from about 1:1 to about 10:1.

92. The method according to claim 89, further comprising cooling exterior surfaces of said molded article by conductive heat transfer or convective heat transfer.

93. The method according to claim 92 wherein said exterior cooling step occurs simultaneously with, at least partially simultaneously with, or sequentially with said annular flow creating step.

94. An apparatus for forming a molded article comprising:

mold means for forming a molded article;

means for removing said molded article from said mold means while said molded article retains sufficient heat to cause crystallinity in said molded article; and

means for creating an annular flow of cooling fluid within a dome portion of said molded article so as to prevent crystallization at least within said dome portion.

95. The apparatus according to claim 94, wherein said annular flow creating means comprises a cooling pin positioned within said molded article, said cooling pin having a central axis aligned with a central axis of said molded article and an outer surface which is spaced from an interior surface of said molded article by a distance D.

96. The apparatus according to claim 95, wherein said cooling pin has an outlet nozzle which is spaced from an interior surface of said dome portion of said molded article by a distance d and wherein the ratio of d:D is in the range

of from about 1:1 to about 10:1 so as to create said annular flow.

97. The apparatus according to claim 96, wherein said outlet nozzle is formed by a divergent nozzle structure.

98. The apparatus according to claim 94, further comprising means for cooling exterior surfaces of said molded article by heat conduction transfer or heat convection transfer.